

Literature analysis and research progress of the landscape ecology in China in the 1990s

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Abstract: This paper makes analysis of published articles and books on landscape ecology in the 1990s through literature collection. The analytical results showed that the study of landscape ecology had made a great advance during the past decade in China. By incomplete survey, Chinese researchers at home and abroad published 619 scientific articles and 13 monographs on landscape ecology in the 1990s, and most of them (more than 90%) were published in Chinese with English abstracts. The published articles on basic theory accounted for 39.6% (245 articles), and those concerning application and methods accounted for 36.8% (228) and 23.6% (146), respectively. According to the objects of research, the published articles on landscape ecology were classified into nine catalogues. The urban landscape ranks first in terms of number of published articles, accounting for 13.4% of the total, followed by regional and river basin landscape, cold and arid landscape, forest landscape, habitat and bio-diversity landscape, agricultural landscape, wetlands, suburban landscape, and vegetation landscape. Based on the analysis, some discussions were made on the existing problems and development trend of landscape ecology study in China

Keywords: Landscape ecology; Literature analysis; Research progress; China

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Introduction

The term 'landscape ecology' was coined by a German bio-geographer, Carl Troll in 1939, when he studied Eastern African land use with aerial photographs. In 1981, the first International Conference on Landscape Ecology was held in the Netherlands and followed in 1982 by the foundation of the International Association for Landscape Ecology (IALE) in Czechoslovakia.

The study of landscape ecology by Chinese researchers started in 1981. Two articles were published by *Scientia Geographica Sinica* in 1981 discussing landscape ecology in the Federal Republic of Germany (Huang 1981) and Czechoslovakia (Liu 1981). These were the earliest records about landscape ecology in a Chinese journal. Huang Xichou and Li Chong (1984) published the first article on Chinese landscape ecological research: An analysis on the ecology of alpine tundra landscape of Changbai Mountains. In addition, other researchers such as Fu Bojie (1983), Chen Changdu (1985, 1986), Jing Guihe (1986, 1989), Yu Kongjian (1987), and Xiao Duning *et al.* (1988) made further contributions to the foundation of landscape ecology in China.

The first national symposium on landscape ecology was

held in Shenyang in October 1989, the second and the third were organized in Beijing in 1996 and in Kunming in 1999, respectively. The IALE-China branch was established in 1996. The International Conference on Landscape Ecology of Asia and Pacific Region (IALE-AP'98) was conducted for the first time in Shenyang, China, in 1998. More than 80 participants from 13 countries attended this conference. Both the national and international conferences have greatly enhanced the development of landscape ecological research in China.

Materials and methods

Principles of literatures collected

According to the definition described in 1998, landscape ecology is a transdisciplinary science at the interface between natural and social science. Landscape ecology in China had a wide range of disciplines and subjects such as ecology, environment, natural resources management, urban and rural planning, and garden design, and tourism development. Therefore, the books and articles published on landscape ecology are widely distributed in many subjects of ecology and environment journals. The main principles for literatures collected are: 1) Literatures in Chinese are mainly cited from journals of earth sciences, biological sciences, forestry sciences, agricultural sciences, and environmental sciences from 1990 to 2000; 2) Literatures in English are mainly based on an English index journal, *Ecological Abstracts* published by Elsevier Science from 1990 to 2000; 3) Literatures collected are of the researches by Chinese ecologists on landscape ecology in China; 4) Literatures collected include monographs, academic re-

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search articles, review articles and reports.

Results and analyses

Statistical analysis

According to the principals for literatures collected, 619 articles and 13 books on landscape ecology have been published by Chinese authors in China and abroad in the 1990s. Owing to our limited capabilities, of course, it is absolutely incomplete survey. Based on literatures collected, simple statistics and analyses are carried out according to different aspects.

Books published

Since Landscape Ecology written by R. Forman and M. Godron was firstly translated into Chinese by Xiao Duning, *et al.* in 1990, 13 books on landscape ecology have been published by Chinese authors in the 1990s (Table 1), of which 12 books were published in Chinese and one book written by Li Xiuzhen was published in English by Wageningen University Press, the Netherlands.

Table 1. Books published on landscape ecology in the 1990s

No.	Author	Book title	Press	Year
1	Jing Guihe	Landscape ecological construction of sandy area in the centre and western part of Jilin Province	North-east Normal University Press	1990
2	Xiao Duning	Landscape ecology: theory, methods and applications	China Forestry Press	1991
3	Dong Yawen	Urban landscape ecology	Commercial Printing House	1993
4	Xu Hui, <i>et al.</i>	Landscape ecological theories and applications	China Environmental Science Press	1993
5	Jing Guihe, <i>et al.</i>	Landscape ecological construction of forest-fringe belt in the east of Jilin Province	North-east Normal University Press	1994
6	Xu Huacheng	Landscape ecology	China Forestry Press	1996
7	Yang Zisheng	Study on the change of landscape pattern dynamics and optimizing design of rural area in Nujiang river gorge	Yunna University Press	1996
8	Yang Shuhua, <i>et al.</i>	The control of surface pollution and landscape pattern in Dianchi lake valley	Yunnan Science & Technology Press	1998
9	Xie Binggeng, <i>et al.</i>	Wetlands landscape ecology	Mid-south Industrial University Press	1998
10	Yu Kongjian	Landscape: culture, ecology and perception	Science Press	1998
11	Xiao Duning	Progress in landscape ecology	Hunan Science & Technology Press	1999
12	Li Xiuzhen	Purification function of wetlands: spatial modeling and pattern analysis of nutrient reduction in the Liaohe delta	Wageningen University Press	2000
13	Wu Jianguo	Landscape ecology: pattern, process, scale and hierarchy	Higher Education Press	2000

Journal articles

There is still no dedicated journal to landscape ecology in China. According to our collections of recent literature, 619 journal articles related to landscape ecology have been published by Chinese ecologists in more than 90 journals in

China and abroad in the 1990s. Among them, 49 articles were in English and 570 articles were in Chinese, which respectively represented 7.9% and 92.1% of the total. From the 90 journals, more than 5 articles on landscape ecology in China (Table 2) were published in 18 journals.

Table 2. Main publications on landscape ecology in China in the 1990s

Order	Journal	Number	Proportion
1	Chinese Journal of Applied Ecology	51	8.2%
2	Acta Ecologica Sinica	42	6.9%
3	Chinese Journal of Ecology	24	3.9%
4	Urban Environment & Urban Ecology	19	3.1%
5	Journal of Environmental Sciences (in English)	16	2.6%
6	Scientia Geographica Sinica	13	2.1%
6	Geographical Research	13	2.1%
8	Journal of Beijing Forestry University	12	1.9%
9	Journal of Desert Research	11	1.8%
10	Advance in Earth Sciences	10	1.6%
10	Acta Phytocool Sinica	10	1.6%
10	Development of Research Network for Natural Resources, Environment and Ecology	10	1.6%
13	Acta Geographica Sinica	9	1.5%
13	Rural Eco-Environment	9	1.5%
15	Journal of Natural Resources	8	1.3%
16	Arid Land Geography	6	0.9%
16	Chinese Geographical Science (in English)	6	0.9%
18	Journal of Lanzhou University (Naturalism)	5	0.8%

In total, 274 articles have been published in these 18 journals, accounting for 44.3% of the total. Moreover, most of the 18 journals were articles in ecology and geography related, such as Chinese Journal of Applied Ecology, *Acta Ecologica Sinica*, Chinese Journal of Ecology, *Scientia Geographica Sinica*, *Geographical Research*, and *Acta Geographica Sinica*, etc. In addition, two journals in English language are published in China: *Journal of Environmental Science* and *Chinese Geographical Science*, which contain many landscape ecological articles in English.

Distribution of authors

Most authors have published one to two articles for each, which constitutes 52.9% of the journal articles. Seven authors published more than 10 articles, which added up to 124 articles and account for 20.0% of the total. They are Xiao Duning, the Vice-president of IALE (40); Zeng Hui and Yu Kongjian (17 each), Zhao Yi (15); Wang Yanglin (13), Fu Bojie (12), and Li Xiuzhen (10). Among these seven authors, Xiao Duning, Zhao Yi and Li Xiuzhen are from the Institute of Applied Ecology and Chinese Academy of Sciences, Fu Bojie is from the research Center for Eco-Environment and Chinese Academy of Sciences, and Zeng Hui, Yu Kongjian and Wang Yanglin are from Beijing University. These organizations have been the leading research centers of landscape ecology in China. Besides these seven authors, many authors are from Beijing Forestry University, Yunnan University, Cold and Arid Regions Environment and Engineering Research Institute, Chinese Academy of Sciences, Lanzhou University and East-ern-China Normal University.

Researches on different contents

Chinese landscape ecological research emphasizes particularly on basic theories and applications. Studies on methods are relatively few, particularly in respect to the study on remote sensing, GIS techniques, and landscape models. According to our statistic, the published articles on basic theory account for 39.6% (245 articles), and those concerning application and methods account for 36.8% (228) and 23.6% (146), respectively. Significant research includes landscape ecological basic theory (Wu *et al.* 1992; Wang 1996; Xiao *et al.* 1999; Fu *et al.* 1999 and Wu 2000), remote sensing and GIS techniques (Chang, *et al.* 1997; Zeng *et al.* 1999 and Bu *et al.* 1999), landscape dynamic models (He *et al.* 1991; Shao *et al.* 1991 and Xie *et al.* 1996), ecological risk evaluation and decision modeling in a desert area (Li *et al.* 1999c).

Studies on different objects

According to the objects of research, the published articles on landscape ecology can be classified into nine catalogues (Table 3). The urban landscape ranks first in terms of number of published articles, accounting for 13.4% of the total, followed by regional and river basin landscape, cold and arid landscape, forest landscape, habitat and

bio-diversity landscape, agricultural landscape, wetlands, suburban landscape, and vegetation landscape. The studies on landscape diversity (Fu *et al.* 1996; Chen *et al.* 1999), forest landscape (Xu *et al.* 1994 and Guo *et al.* 1999), wetlands (Xiao *et al.* 1996; Hu *et al.* 1999; Li *et al.* 1999b and Wang *et al.* 2000b), suburban landscape (Zhao 1996), urban landscape (Zong 1998; Li *et al.* 1999a; Guan *et al.* 1999), arid area, and oasis landscape (Chang *et al.* 1998, 1997; Zhou 1999; Wang *et al.* 2000a) were all of importance in terms of ecological science and application.

Table 3. Articles published on different objects in the 1990s

Order	Objects	Number	Proportion
1	Urban landscape	83	13.4%
2	Regional & river basin landscape	81	13.1%
3	Cold & arid regional landscape	53	8.6%
3	Forest landscape	53	8.6%
5	Habitat & biodiversity landscape	39	6.3%
6	Agricultural landscape	38	6.1%
7	Wetlands landscape	32	5.2%
8	Suburb landscape	31	5.0%
9	Plant landscape	19	3.1%
Others	-	-	-

Overview on structure, process, and change of landscape

Landscape ecology is a subject focusing on landscape structure (spatial pattern), landscape process (function) and landscape change (dynamics). Up to now, the study on landscape structure and spatial pattern is still high ranking by Chinese landscape ecologists. According to our statistics, 169 articles were related to this subject. However, the studies on the landscape process and function and the landscape change and dynamics were comparatively few. There were only 79 and 85 articles dealing with the two subjects, respectively. Among them, the research on landscape security pattern (Yu 1996), urban landscape pattern (Zong 1998; Li *et al.* 1999a), landscape pattern-process (Wang 1998), and landscape change (Zeng *et al.* 2000) were of significance.

Trends in landscape ecological research in China

Based on the information and literature, some trends in landscape ecological research in China are summarized and outlined: 1) Practicability: based on theories and principles of landscape ecology, the landscape ecology was widely applied in many ways such as regional ecological planning, urban and suburban constructing, gardens designing, and eco-tourism developing; 2) Universality: the researches on landscape ecology refer broadly to many aspects of the subjects of ecological environment in China from the national, city and forest to the local, village and desert; 3) Concentricity: much more subjects are focusing on the analysis on the landscape structure and landscape pattern, however, there is far lack of the studies on the relationship between landscape pattern and ecological

process; 4) Monotonicity: the methods on landscape ecology are still simply emphasizing on the calculating and analyzing on the variety of landscape index rather than applying the integration measures between experiments, models, GIS and remote sensing technologies, and 5) Discontinuousness: it is discontinuous for scales which are taken more attention to the isolated medium and small landscape scales while are deficient in the systemic studying on larger and macro-scales.

Discussion

Landscape ecological research in China has made advanced progress since its introduction. However, we still have a long way to go, compared to Europe and North America, to develop landscape ecology responsive to Chinese conditions. China is a developing country with vast areas, a large population and a long history. Excessive agricultural land use has become a serious problem in many places. Therefore, we should focus on the man-made-natural landscapes as well as managed landscapes, and pay more attention to ecological reconstruction at landscape and regional scale. Landscape ecological construction is based on the management and reconstruction of landscape units, which include the adjustment of the original landscape pattern, building new landscape components and so on, in order to improve the function of production of damaged ecosystems, enhance the total productivity and stability of the landscape systems and guide the influence of human activities on landscape change through positive feedback loops.

The targets and components of landscape ecological construction are: 1) To adjust and construct new spatial structures, increase heterogeneity and stability and create improved economic and ecological benefits for landscape systems; 2) To control human activities, compensate and recover the ecological functions of landscape, such as alteration of land use and adjustment of cultivation, grazing and harvesting; 3) To increase the total productivity of ecosystems in the landscape by developing and producing renewable natural resources on the basis of ecological principles; 4) To build man-made landscapes by imitating natural systems.

In view of the development of social and economic conditions in China, as well as the improvement of people's awareness of nature conservation, we believe that research and applications of landscape ecology will gain more attention and make progress. We believe that, with the effort of all Chinese landscape ecologists and help from international experts, landscape ecology research will become increasingly valued in China.

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